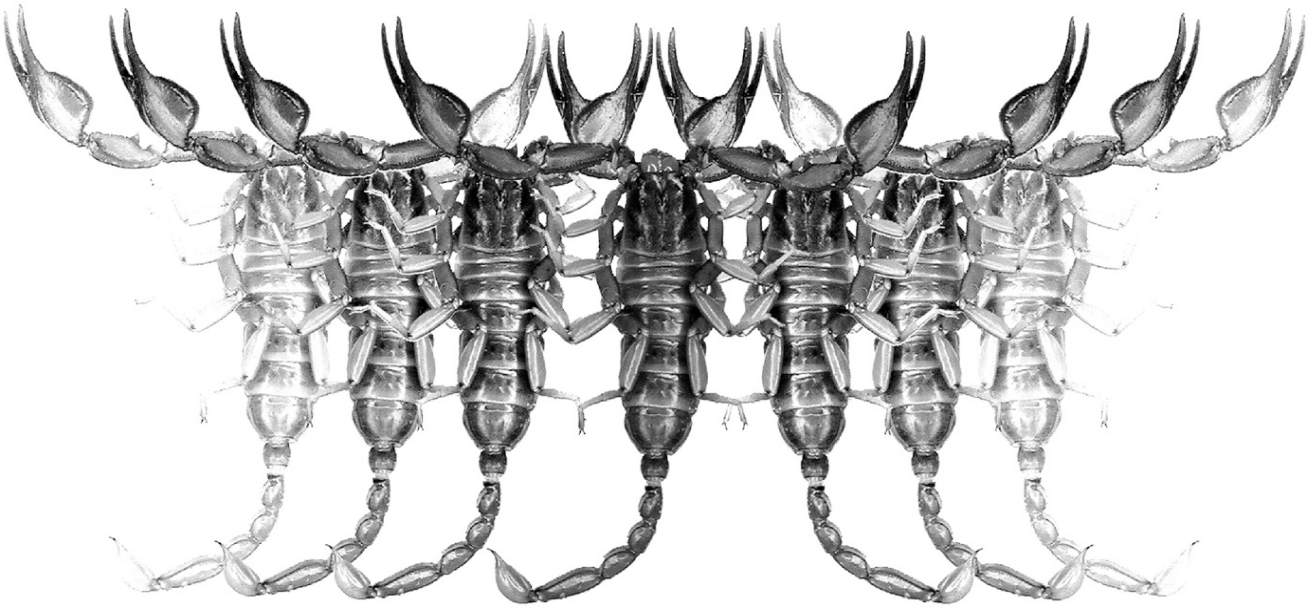
Euscorpius

Occasional Publications in Scorpiology



Another new species of *Euscorpius* Thorell, 1876 from the caves of Croatia and Bosnia-Herzegovina (Scorpiones: Euscorpiidae), with notes on biogeography and cave ecology

Gioele Tropea & Roman Ozimec

May 2020 — No. 308

Euscorpius

Occasional Publications in Scorpiology

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Derivatio Nominis

The name ***Euscorpius*** Thorell, 1876 refers to the most common genus of scorpions in the Mediterranean region and southern Europe (family Euscorpiidae).

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Publication date: 4 May 2020

http://zoobank.org/urn:lsid:zoobank.org:pub:A0FEB348-1BB2-4351-8F1D-79F28F833BF8

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Another new species of *Euscorpius* Thorell, 1876 from the caves of Croatia and Bosnia-Herzegovina (Scorpiones: Euscorpiidae), with notes on biogeography and cave ecology

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Summary

Another new, subtroglophile scorpion species is described from Croatia, *Euscorpius biokovensis* **sp**. **n**. It is morphologically and ecologically similar to *E. feti* Tropea, 2013 but can be distinguished from the latter by a lower number of trichobothria (*Pv* = 8–9, with mostly 8, and usually *et* = 6) and pectinal teeth (usually *Dp* = 7 in males and 6 in females). The new species also has a more northern distribution although in some areas the two species overlap. *E. biokovensis* **sp**. **n**. has been found in more than 20 caves in Croatia, which makes it the most common *Euscorpius* species found in caves. It has also been found in Bosnia-Herzegovina. Ecological notes on this species are presented.

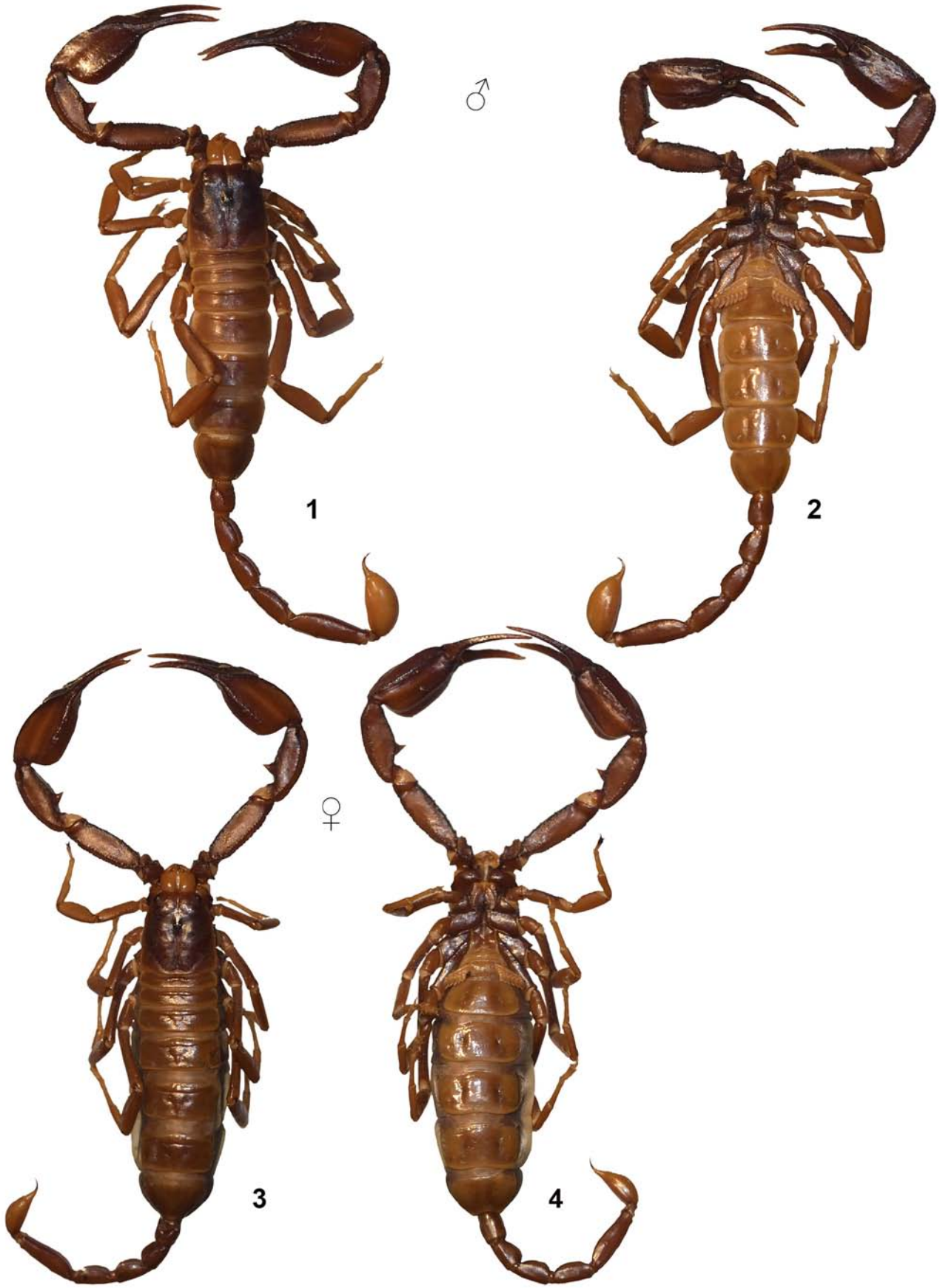
Introduction

The Croatian scorpion fauna has been little studied. The taxonomic position of various scorpion populations remained doubtful (Di Caporiacco, 1950; Kinzelbach, 1975) until a few years ago, when several publications attempted to clarify the position of at least some taxa (Graham et al., 2012; Tropea, 2013a, 2013b, 2015). Status of some populations is still to be clarified (Tropea et al., in progress). To date, the scorpion fauna of Croatia is represented by only one family, Euscorpiidae, with the following species (not including *Euscorpius biokovensis* **sp**. **n**.): *Alpiscorpius gamma* (Di Caporiacco, 1950), *Euscorpius aquilejensis* (C. L. Koch, 1837), *E. borovaglavaensis* Tropea, 2015, *E. croaticus* Di Caporiacco, 1950, *E. feti* Tropea, 2013, *E. garganicus* Di Caporiacco, 1950, *E. italicus* (Herbst, 1800), *E. tergestinus* (C.L. Koch, 1837), and *E. hadzii* Di Caporiacco, 1950 (Fet & Soleglad, 2002; Gantenbein et al., 2002; Graham et al., 2012; Scherabon et al., 2000; Tropea, 2013a, 2013b, 2015, 2017; Tropea & Ozimec, 2019). Here, a new species, *E. biokovensis* **sp**. **n**., is described, based on numerous specimens from more than 20 caves in the West Balkans. In addition, some ecological notes on cave specimens are presented. Discovery of numerous specimens in so many caves suggests that the new species, similarly to *E. feti*, can easily adapt to, or even prefer, cave habitats and thus can be classified as a subtroglophile or an opportunistic eutroglophile.

Methods, Material & Abbreviations

The trichobothrial notation follows Vachon (1974). Morphological measurements (given in millimetres) and abbreviations follow Tropea et al. (2014), but we use *Wchel*=*WchelA* and *Dtel*=*Htel*. Morphological nomenclature follows Stahnke (1971), Hjelle (1990) and Sissom (1990); the chela carinae and denticle configuration follows Soleglad & Sissom (2001) but we united *ID+IAD*. Cave habitats are defined for EU countries following EUNIS habitat classification 2007 (Revised Descriptions…, 2012). However, since this classification does not cover all the specifics of individual countries, we added the most detailed classification for cave habitats following the National Classification of Habitats of the Republic of Croatia (IV version). The map was downloaded from http://d-maps.com and edited. Photographs in Figs. 1–18 by G. T, in Figs. 19–24 by R. O.

Abbreviations. *Dp*: pectinal teeth number; *Pe*: trichobothria on pedipalp patella external surface; *L*: length; *D*: depth; *Lchel*: chela length; *Wchel:* chela width (= *WchelA* of Tropea *et al*., 2014); *Lcar*: carapace length; *Wcar*: carapace width; *Lfem*: femur length; *Lpat*: patella length; *Ltel*: telson length; *Dtel*: telson depth (= *Htel* of Tropea et al., 2014); *Lmet*: sum of the length of all metasomal segments; *Wmet:* sum of the width of all metasomal segments; *met.seg*: metasomal segment; *CarA-CarP %*: distances from centre of median eyes to anterior and posterior margins of the carapace; juv.: juvenile (immature specimen in any stage of development).



Figures 1–**4**: *Euscorpius biokovensis* **sp**. **n**. **Figures 1**–**2**. Male holotype in dorsal (1) and ventral (2) views. **Figures 3**–**4**. Female paratype in dorsal (3) and ventral (4) views.

Dimensions (mm)		*E. biokovensis* sp. n. ♂ holotype	*E. biokovensis* sp. n. ♀ paratype
Carapace	L / W	5.28 / 4.80	5.28 / 4.87
Metasoma + telson	L	18.89	16.78
Segment I	L / W	1.74 / 1.62	1.56 / 1.56
Segment II	L / W	2.10 / 1.47	1.85 / 1.38
Segment III	L / W	2.45 / 1.39	2.16 / 1.32
Segment IV	L / W	2.82 / 1.32	2.51 / 1.21
Segment V	L / W	4.80 / 1.36	4.50 / 1.26
Telson	L / W / D	4.98 / 1.92 / 1.95	4.20 / 1.38 / 1.32
Vesicle	L	3.60	3.30
Pedipalp	L	21.00	24.06
Femur	L / W	5.52 / 1.78	5.46 / 1.83
Patella	L / W	4.98 / 1.86	4.98 / 1,86
Chela	L / W	10.50 / 3.18	10.14 / 3.24
Movable finger	L	5.94	5.82
Total	**L**	**35.04**	**33.94**

Table 1. Measurements (mm) of *Euscorpius biokovensis* **sp**. **n**. male holotype and a female paratype

Specimen depositories. GTC: private collection of Gioele Tropea, Rome, Italy; and ROC: private collection of Roman Ozimec, Zagreb, Croatia. Some type specimens will be deposited in NHMS (Natural History Museum Split, Croatia) and MSNB (Museo Civico di Scienze Naturali "E. Caffi", Bergamo, Italy).

Material examined for comparison. See the examined specimens in Tropea (2013a, 2013b, 2015), Tropea & Ozimec (2019).

Systematics

Family **Euscorpiidae** Laurie, 1896
Genus ***Euscorpius*** Thorell, 1876
Subgenus *Incertae Sedis*

Euscorpius biokovensis sp. n.

(Figures 1–20, Tables 1–3)

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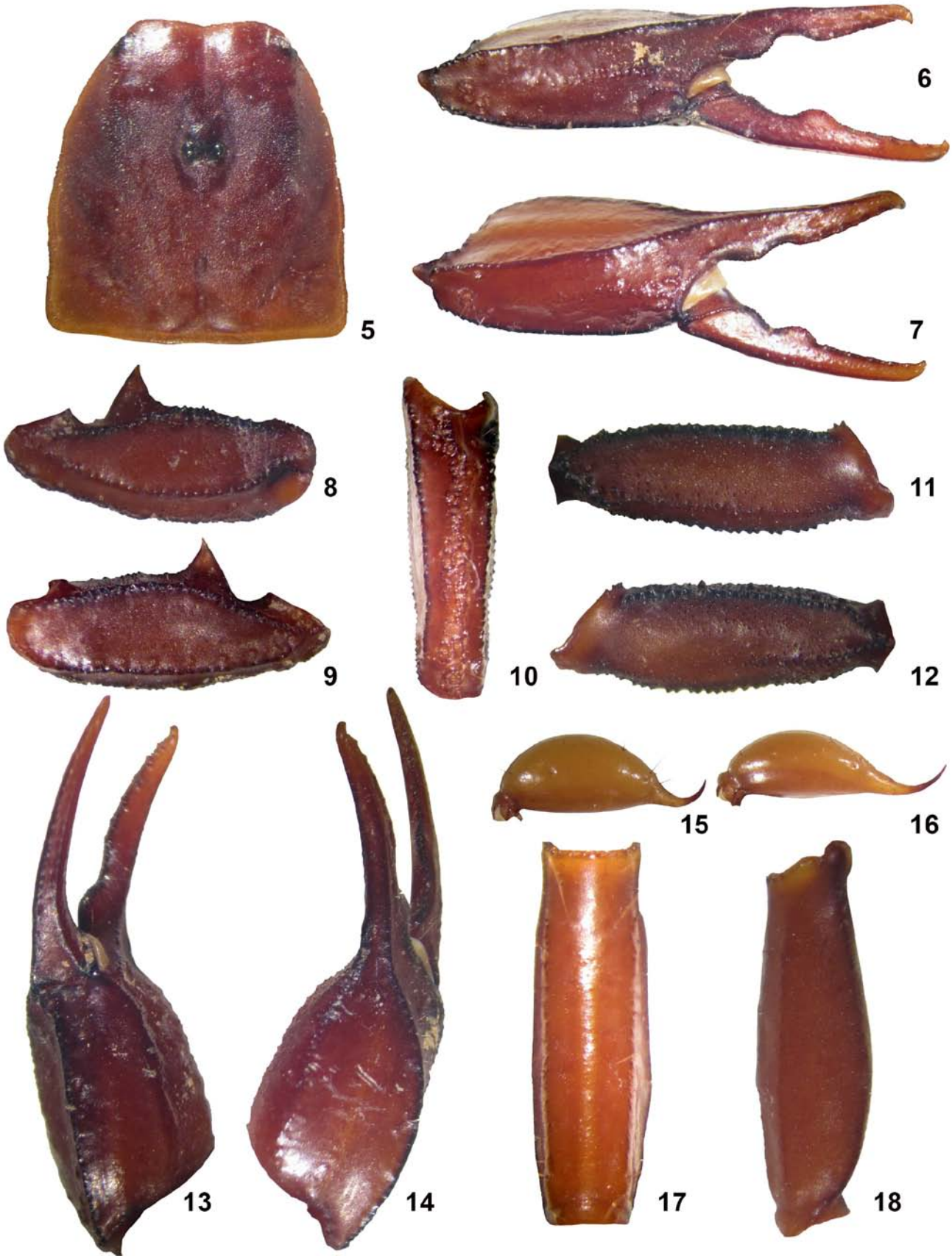
Type locality and type repository. Croatia, Biokovo Mts., Drinova 2 Cave, Bartulovići, 43°24'27.6"N 16°56'51.9"E, 525 m a. s. l.; GTC.

Type material. **Croatia**, **Biokovo Mts**.: Drinova 2 Cave, Bartulovići, 43°24'27.6"N 16°56'51.9"E, 525 m a. s. l., leg. R. Ozimec and I. Vuković, 5 October 2018, 1♂ (holotype), GTC 1156; Baba Cave, Štedovac, 43°15'23.3"N 17°09'44.2"E, leg. R. Ozimec and I. Vuković, 10 October 2018, 1♂1♀ (paratypes), GTC; Brikinjava Cave, Župa, leg. M. Pavlek, 17 November 2005, 2♀ (paratypes), ROC; Cave in Radinovci, Rastovac, leg. R. Ozimec, 25 October 2006, 1♀ (paratype), ROC; Gradina (Jujnovića) Cave, Kozica, leg. R. Ozimec, 25 August 2011, 1♀ (paratype), GTC; leg. R. Ozimec, 6 November 2017, 1♂juv.1♀ (paratypes), ROC; Gradska Cave, Župa, leg. R. Ozimec, 5 November 2015, 1♂juv.1♀ (paratypes), ROC; Jama za Supinom Pit, leg. R. Ozimec, 4 November 2015, 1♀ (paratype), ROC; Kukor Cave, Bast, leg. R. Ozimec, 7 August 2000, 2♀ (paratypes), ROC, 23 June 2007, 1♀ (paratype), ROC, 19 August 2008, 1♀ (paratype), ROC, 4 November 2009, 1♂ (paratype), ROC, 8 November 2015, 1♂juv.1♀1♀juv. (paratypes), ROC, 24 August 2017, 1♂ (paratype), GTC, 7 October 2018, 3♀ (paratypes), ROC, leg. D. Basara and P. Visković, 7 October 2018, 1♀juv. (paratype), ROC, leg. D. Basara, M. Klisović and T. Tursić, 6 November 2017, 2♀ (paratypes), ROC; Mala Jama Pit, Bratuš, leg. R. Ozimec, 11 October 2018, 1♀juv. (paratype), ROC; Plužina Cave, Zagvozd, leg. R. Ozimec, 15 October 2002, 1♂ (paratype), ROC; Podrum Cave, Podgora, leg. R. Ozimec, 23 February 2002, 1♀ (paratype), ROC; Rakova Cave, Brela, leg. R. Ozimec, 3 November 2015, 1♂juv.1♀juv. (paratypes), ROC; Stara Škola Pit (at the entrance, deep under stones), leg. R. Ozimec, 20 June 2016, 1♂juv. (paratype), ROC; Stonska Peć, Župa, leg. R. & D. Ozimec, 20 August 2016, 1♂1♀ (paratypes), ROC); Svetica Cave, Gornja Brela, leg. R. Ozimec, 22 May 2004, 1♂ (paratype), ROC; Vrstalinka Pit, Kozica, leg. R. Ozimec, 26 March 2003, 1♀ (paratype), GTC; Zlatna Cave, Lađena, R. Ozimec, 21 October 2018, 1♀juv. (paratype), ROC.

Other material examined. **Bosnia-Herzegovina**, Konjic-Jablanica, 1♀, GTC; Stara Đurkovica, Grebca, Ravno, 42°44'28.7"N 18°04'56.9"E, leg. L. Marko, 31 May 2005, 1♂juv., GTC. **Croatia**, Đuderina Cave, Krizani, Split, Dugopolje, leg. J. Bedek, 7 May 2005, 1♂juv., ROC; Golubinka 2 Pit, Pupnat, Korčula Island, leg. A. Kirin, 20



Figures 5–**18**: *Euscorpius biokovensis* **sp**. **n**. **Figures 5–6**, **8–15**, **17–18**. Male holotype, carapace (5), pedipalp chela external (6), ventral (13) and dorsal (14) views, pedipalp patella dorsal (8), ventral (9) and external (10) views, pedipalp femur dorsal (11) and ventral (12) views, telson lateral (15), metasoma V ventral (17) and lateral (18) views. **Figures 7**, **16**. Female paratype, pedipalp chela external (7) and telson lateral (16).

March 2010, 1♂, ROC; Jama u Dubokom dolu pit, Korčula Island, 27 April 2004, leg. R. Ozimec, 1♀, ROC; Golubska Jama Pit, Ponikve, Pelješac, Dubrovnik, leg. R. Ozimec, 22 November 2011, 1♂, ROC; Nikolina Cave, Kućiće, Omiš, leg. M. Franičević, 23 March 2003, 2♂juvs.3♀juvs., ROC; Maklutača Cave, Dugopolje, Split, leg. SUK i T.R., 22 April 2000, 1♂, ROC; Trojama Pit, Mosor Mts., Split, leg. R. Ozimec, 6 May 2005, 1♀juv., ROC; Velika Špilja Cave by Neorić, Bazine, Sutina, Neorić, Muć, Sinj, Middle Dalmatia, leg. A. Kirin, 28 April 2012, 2♀juvs., ROC.

Etymology. The specific epithet is derived from Biokovo Mts., where the type locality is situated.

Diagnosis. A medium-large *Euscorpius* species of total length 30–40 mm, particularly elongated. Colour of adults light brown to light brown-reddish without reticulation or marbling, with carapace and pedipalps darker reddish. Number of trichobothria on the pedipalp manus ventral surface is 4 (3 V +Et_1); the number of trichobothria on the pedipalp patella ventral surface usually is 8 or 9 (8 in 67.92% and 9 in 29.24% of the pedipalps examined). Number of trichobothria on pedipalp patella external surface usually is: *eb* = 4, eb_a = 4, *esb* = 2, *em* = 4, *est* = 4, *et* = 6. Pectinal teeth count usually is 7 in males and 6 in females. Metasomal segment I longer than wide in males and usually longer than wide, but it may also be slightly wider than long, in females; average *L/W met. seg*. I ratio 1.13 in males and 1.03 in females. Chela elongated with long finger; *Lchel/Wchel* ratio is 3.09 in males and 3.18 in females. Dorsal patellar spur highly developed. Femur longer than patella; *Lfem/Lpat* ratio is 1.12. Carapace longer than wide; average ratio *Lcar/Wcar* 1.09; average distance from centre of median eyes to anterior margin of the carapace is 39.35% of the carapace length and from centre of median eyes to posterior margin of the carapace is 60.65% of the carapace length. Average ratio of *Lmet/Lcar* is 2.66 in males and 2.34 in females. Metasomal segment *V* with little marked carinae, the ventrolateral carinae little marked, spaced and with slightly serrulated granules, and ventromedian carina little marked and with the normal granulation present on the entire intercarinal surface on segment. Ventral surface of tarsus with spinules positioned in a single straight row or ending with a decentralized distal spinule.

Trichobothrial and pectinal teeth count variation. The variation observed in 53 examined specimens (19 males, 34 females) is given below (left/right asymmetry not specified).
Pectinal teeth in males (n=19): 6/7 (2), 7/7 (12), 7/8 (5); in total, 6 in 5.26% (2), 7 in 81.58% (31) and 8 in 13.16% (5); mean = 7.08, SD 0.43.
Pectinal teeth in females (n=34): 6/5 (2), 6/6 (29), 7/6 (1), 7/7 (1), 8/8 (1); in total, 5 in 2.94% (2), 6 in 89.71% (61), 7 in 4.41% (3) and 8 in 2.94% (2); mean = 6.07, SD 0.43.
Pedipalp patella trichobothria *Pv* (n=53): 7/7 (1), 8/7 (1), 8/8 (28), 8/9 (15), 9/9 (8); in total, 7 in 2.83% (3), 8 in 67.92% (72) and 9 in 29.24% (31); mean = 8.26, SD 0.50.
Pedipalp patella trichobothria *Pe* (n=53): *et* = 5/6 (1), 6/6 (48), 6/7 (3), 7/7 (1); in total, 5 in 0.94% (1), 6 in 94.34% (100) and 7 in 4.72% (5); mean = 6.04, SD 0.24; *est*= 4/4 (53); *em*= ?/4 (1), 3/4 (1), 4/4 (51); *esb*= ?/2 (1), 1/2 (3), 2/2 (49); eb_a = ?/4 (1), 3/4 (1), 4/4 (51); *eb* = 3/4 (1), 4/4 (52).

Sexual dimorphism. Largely the same as in most species of Euscorpiinae. The male has a much more swollen telson than the female; average *Ltel/Wtel* 2.42 in males and 3.17 in females. The metasoma usually is more elongated in males; *Lmet/Wmet* 1.99 in males vs. 1.89 in female. Males have the fixed finger of chela with a most marked notch corresponding to the lobe on movable finger than females. Males have higher number of pectinal teeth (*Dp* 7 in 81.58% and 8 in 13.16%, mean = 7.08, SD 0.43) than females (6 in 89.71%, mean = 6.07, SD 0.43). The males have the genital operculum with genital papillae protruding. Males in general more granulated.

Description (♂ holotype). **Coloration**. General colour light brown-orange with carapace darker, reddish; sternites, chelicerae, pectines, genital operculum and telson light orange/brownish; darker carinae, specially the internal carinae of pedipalps, blackish.
Carapace. Fine granulation on whole surface, with granules becoming gradually larger toward the lateral area, especially in anterior part, from median eyes to half of carapace length; anterior edge slightly granulate to granulate and sunken; deep anterior median, posterior median and posterior lateral furrows, the latter two combine to form two protuberances at the posterior margin; two pairs of lateral eyes (with a larger anterior eye), and a pair of median eyes, situated anteriorly of the middle; distance from centre of median eyes to the anterior margin is 41.48% of carapace length; distance from centre of median eyes to posterior margin is 58.52% of the carapace length.
Mesosoma. Tergites very finely and homogeneously granulated; sternites finely punctated except the last sternite, which is laterally finely granulated; small spiracles inclined to about 45° downward towards outside; area of overlap between sternites very pale.
Metasoma. All the segments longer than wide. Dorsal carinae on segments I–IV granulated; dorsolateral carinae on segments I-III with some granules proximally and after smooth or obsolete; ventrolateral carinae absent on segment I, smooth on segments II–IV, with little marked, spaced and slightly serrulated granules on segment V; ventromedian carina absent on the segments I–IV, little marked and with the normal granulation present on the whole intercarinal surface on segment V; intercarinal spaces very finely granulated on dorsal and lateral surfaces and on ventral surface of the segment V, smooth or almost smooth on the others surfaces of the segments I–IV.
Telson. Vesicle with a few scattered, very small granules, with ventral setae of different size, especially near the vesicle/aculeus juncture.
Pectines. Tooth count 7/7; middle lamellae count 4 or 5/4 or 5; several microsetae on marginal lamellae, middle lamellae and fulcra.

***E. biokovensis* sp. n.** **Ratios**	♂ **holotype**	♀ **paratype**
CarA-CarP	41.48-58.52	40.23-59.77
Lcar/Wcar	1.10	1.08
Lcar/Lfem	0.96	0.97
Lcar/Lpat	1.06	1.06
Lcar/Ltel	1.06	1.26
Lchel/Wchel	3.30	3.13
L/W met.seg I	1.07	1.00
L/W met.seg II	1.43	1.34
L/W met.seg III	1.78	1.64
L/W met.seg IV	2.14	2.07
L/W met.seg V	3.54	3.57
Lmet/Wmet	1.95	1.87
Lmet/Lcar	2.64	2.38
Lfem/Lpat	1.11	1.10
Dtel/Wtel	1.92	0.96

Table 2. Some ratios of *Euscorpius biokovensis* **sp**. **n**. male holotype and a female paratype

Genital operculum. Formed by two subtriangular sclerites partially divided with genital papillae protruding; a few microsetae are present.

Sternum. Pentagonal in shape, more or less as long as wide, with a deep posterior emargination.

Pedipalps. Coxa and trochanter with tuberculated carinae. Femur: dorsal internal carinae tuberculated; dorsal external carinae formed by tubercles slightly spaced; external median carinae serrulated; ventral internal carinae tuberculated; ventral external carinae formed by spaced tubercles, well-formed only in the proximal half; anterior median formed by a few spaced, conical tubercles, varying in size, of which the larger three bear a macroseta each; dorsal intercarinal spaces granulated, with larger granules near the internal carina; ventral intercarinal spaces not uniformly granulated, with larger granules near ventral internal carinae. Patella: dorsal internal carinae tuberculated; dorsal external carinae crenulated; ventral external carinae crenulated; ventral internal carinae tuberculated to lightly serrulated; dorsal intercarinal surface finely granulated, with larger granules in distal area; ventral intercarinal surface with few scattered minute granules, especially near ventral internal carinae. Dorsal patellar spur highly developed. Chela particularly elongated, with long fingers. Fixed finger with marked notch corresponding to the lobe on movable finger. Chelal carina *D1* distinct, strong, dark and from smooth to slightly crenulated; *D4* is rounded and rough; *V1* distinct, strong, dark and slightly undulated; *V3* rounded, dark with small and scattered granules; external carina granulated; intercarinal tegument rough to finely granulated with very minute scattered granules. Finger dentition: in the most distal part a *DD* on the tip is present; *MD* is formed by very small denticles closely spaced forming a more or less straight line, discontinued at level of the *OD*; fixed finger has 6/6 *OD* and 11/11 *ID*; movable finger has 7/7 *OD* and 13/13 *ID*.

Trichobothria. Chela: trichobothria on the pedipalp manus ventral surface is 4/4 (V_{1-3} + Et_1). Patella: *Pv*: 8/8; patella external (*Pe*): *et* = 6/6, *est* = 4/4, *em* = 4/4, *esb* = 2/2, eb_a = 4/4, *eb* = 4/4. Trichobothrium est_2 is slightly proximal to est_3. Femur: trichobothrium *d* is proximal to *i*, while the trichobothrium *e* is distal to both *d* and *i*; it is situated on dorsal external carina but shifted toward its dorsal surface.

Legs. Legs with two pedal spurs; no tarsal spur; ventral row of tarsus III with a total of about 9 small spinules, of increasing size from proximal to distal, positioned on a single straight row; 3 main flanking pairs of tarsal setae adjacent to the ventral spinule row. Granulation present on dorsal and ventral surface of leg femora, it is mostly marked and dark ventrally.

Chelicerae. Smooth, without marbling or reticulation, with darker apical portion of denticles. Movable finger: the dorsal distal denticle is much smaller than the ventral distal denticle; ventral edge is smooth with brush-like setae on the inner part; dorsal edge has five denticles: one large distal, one medium and one small subdistal, one large median and a small basal. Fixed finger has four denticles: one distal, one subdistal, one median and one basal, the last two in a fork arrangement; the internal surface has brush-like setae.

Affinities. The new taxon can be distinguished from the other scorpion species belonging to the subgenus *Euscorpius* or similar to it, that occur in the same, or nearby, areas as follows.

It is possible to distinguish *E. biokovensis* **sp**. **n**. from the species of "*E. hadzii* complex" by the main following features: (1) the number of trichobothrial in some series on pedipalp patella external surface, which usually are *eba* > 5 and *eb* = 5 in *E. hadzii* complex, versus eb_a = 4 and *eb* = 4 in *E. biokovensis* **sp**. **n**.; (2) *E. biokovensis* **sp**. **n**. is generally more elongated with all segments of the pedipalps and the carapace proportionally longer than in *E. hadzii*; (3) *E. biokovensis* **sp**. **n**. has the spinule series on tarsus positioned in a single straight row or ending with a decentralized distal spinule, while in *E. hadzii* it ends with distal paired spinules formed as a "Y".

Euscorpius biokovensis **sp**. **n**. differs from *E. borovaglavaensis* and *E. tergestinus* mainly in the following features: (1) *E. biokovensis* **sp**. **n**. has general habitus more elongated, with all segments of the pedipalps and the carapace proportionally longer than in *E. borovaglavaensis* and *E. tergestinus*; (2) in *E. biokovensis* **sp**. **n**., because of the elongated chela and more proximal position of the base of fixed finger, the trichobothria *db* and *dsb* occur in more distal position than in *E. borovaglavaensis* and *E. tergestinus*, which have the trichobothrium *db* in basal position and *dsb* more proximally; (3) *E. biokovensis* **sp**. **n**. has a proportionally longer pedipalp femur that is usually longer than pedipalp patella, while *E. borovaglavaensis* and *E. tergestinus* have a more stocky femur which is usually shorter than patella and sometimes as long as it; (4) *E. biokovensis* **sp**. **n**. has a particularly elongated carapace compared with *E. borovaglavaensis* and

Locality	Coordinates	Altitude (m)	Microregion	Macroregion	Country
Baba Cave	43°15'23.3"N 17°09'44.2"E	965	Biokovo Mts.	Middle Dalmatia	Croatia
Brikinjava Cave	43°20'42.7"N 17°05'48.8"E	766	Biokovo Mts.	Middle Dalmatia	Croatia
Cave in Radinovci	43°23'59.1"N 17°00'35.2"E	310	Biokovo Mts.	Middle Dalmatia	Croatia
Drinova 2 Cave	43°24'27.6"N 16°56'51.9"E	525	Biokovo Mts.	Middle Dalmatia	Croatia
Đuderina Cave	43°34'12.0"N 16°36'34.4"E	300	Mosor Mts.	Middle Dalmatia	Croatia
Đurkovica	42°44'28.7"N 18°04'56.9"E	480	Grebci	Hercegovina	BIH
Golubinka 2 Pit	42°57'01.4"N 17°03'15.4"E	356	Korčula Island	South Dalmatia	Croatia
Golubska Pit	42°51'26.6"N 17°37'48.9"E	386	Pelješac Peninsula	South Dalmatia	Croatia
Gradina (Jujnovića) Cave	43°15'53.4"N 17°11'57.3"E	375	Biokovo Mts.	Middle Dalmatia	Croatia
Gradska Cave	43°19'05.1"N 17°07'03.4"E	746	Biokovo Mts.	Middle Dalmatia	Croatia
Jama u Dubokom dolu Pit	42°57'21.8"N 17°03'19.1"E	210	Korčula Island	South Dalmatia	Croatia
Jama za Supinom Pit	43°14'41.9"N 17°06'41.3"E	760	Biokovo Mts.	Middle Dalmatia	Croatia
Kukor Cave (cave in Bast)	43°21'20.2"N 16°59'30.1"E	470	Biokovo Mts.	Middle Dalmatia	Croatia
Maklutača Cave	43°34'09.4"N 16°37'13.8"E	400	Mosor Mts.	Middle Dalmatia	Croatia
Mala Pit	43°19'42.3"N 16°58'45.8"E	25	Biokovo Mts.	Middle Dalmatia	Croatia
Nikolina Cave	43°25'33.8"N 16°49'33.3"E	250	Omiška Dinara Mts.	Middle Dalmatia	Croatia
Podrum Cave	43°14'03.5"N 17°05'30.9"E	180	Biokovo Mts.	Middle Dalmatia	Croatia
Pružina Cave	43°23'39.3"N 17°03'31.3"E	519	Biokovo Mts.	Middle Dalmatia	Croatia
Rakova Cave	43°24'20.3"N 16°53'54.1"E	240	Biokovo Mts.	Middle Dalmatia	Croatia
Stara Škola Pit	43°20'34.3"N 17°02'17.4"E	1550	Biokovo Mts.	Middle Dalmatia	Croatia
Stonjska peć Cave	43°18'54.6"N 17°07'49.4"E	625	Biokovo Mts.	Middle Dalmatia	Croatia
Svetica Cave	43°24'04.1"N 16°53'40.3"E	300	Biokovo Mts.	Middle Dalmatia	Croatia
Trojama Jama	43°30'03.3"N 16°43'32.1"E	730	Mosor Mts.	Middle Dalmatia	Croatia
Velika Cave by Neorić	43°41'10.0"N 16°33'11.2"E	703	Dalm. Zagora	Middle Dalmatia	Croatia
Vlastelinka (Vrstalinka) Pit	43°16'10.7"N 17°12'40.3"E	410	Biokovo Mts.	Middle Dalmatia	Croatia
Zlatna Cave	43°17'48.7"N 17°04'36.0"E	1235	Biokovo Mts.	Middle Dalmatia	Croatia

Table 3. List of cave localities of *Euscorpius biokovensis* **sp**. **n**.

E. tergestinus; its anterior part is on average 39.35% of the total length of carapace, so the eyes occur in more proximal position, while *E. borovaglavaensis* and *E. tergestinus* have a more stocky carapace, with the length of its anterior part is on average 44.17% and 43.21% of the total length of carapace, respectively; (5) *E. biokovensis* **sp**. **n**. has the spinule series on tarsus positioned in a single straight row or ending with a decentralized distal spinule, while in *E. borovaglavaensis* and *E. tergestinus* it ends with distal paired spinules as a "Y"; (6) the colour of the adults is very light brown to light brown-reddish without reticulation or marbling in *E. biokovensis* **sp**. **n**. while *E. borovaglavaensis* is dark brown with marked marbling on most of body.

E. biokovensis **sp**. **n**. differs from *E. aquilejensis* in the following features: (1) *E. biokovensis* **sp**. **n**. has more elongated chelae, with *Lchel/Wchel* average ratio of 3.09 in males and 3.18 in females versus 2.79 in males and 2.89 in females of *E. aquilejensis*; (2) *E. biokovensis* **sp**. **n**. has the metasomal segment I longer than wide in males and usually longer than wide (but it sometimes slightly wider than long) in females, while in *E. aquilejensis* it is wider than long; (3) *E. biokovensis* **sp**. **n**. has the V segment with the ventrolateral carinae with little marked, spaced and slightly serrulated granules and the ventromedian carinae obsolete with the normal granulation present on the whole intercarinal surface while *E. aquilejensis* has both those carinae well-marked and serrulated.

E. biokovensis **sp**. **n**. differs from *E. feti* mostly in the following features: (1) *E. biokovensis* **sp**. **n**. has lower number of patellar trichobothria in some series, *Pv* = 8-9 (mostly 8), and usually *et* = 6, versus usually *Pv* = 11-12 and *et* = 7-8 in *E. feti*; (2) *E. biokovensis* **sp**. **n**. has lower number of pectinal teeth, usually *Dp* = 7 in males and 6 in females while *E. feti* has *Dp* = 8-9 in males and 7-8 in females.

Distribution. Western Balkans: Bosnia & Herzegovina (south), Croatia (south) (Fig. 24).

Ecological and biogeographical notes on cave specimens. The biospeleological studies conducted by the second author in Croatia from 1987 to present, resulted in collecting many scorpion specimens, primary in caves and

Figures 19–**20**: *Euscorpius biokovensis* **sp**. **n**. **Figure 19**. Male holotype, *in situ* in Drinova 2 Cave. **Figure 20**. Female, *in situ* in Kukor Cave while eats a *Dolichopoda araneiformis*.

some similar habitats (mines, underground tunnels). After a detailed taxonomic analysis, performed by the first author, a new *Euscorpius* species is described here, found in 26 caves (Table 3), collected in 2000–2018. It is obvious that *E. biokovensis* **sp**. **n**. has a significant affinity to cave habitats within its predominantly karstic geographic range.

The geographic range of *E. biokovensis* **sp**. **n**. occupies the Mediterranean region of the Dinaric Alps (Dinarides), located mainly in the mountain ranges between the Dalmatian Zagora in the north and the Neretva River in the southeast, including mainly (from south to north): Biokovo Mts., Omiška Dinara Mts., and Mosor Mts. It stretches further to the warm sub-Mediterranean area deep into northeastern Herzegovina (Konjic) via the deep canyon of the Neretva River, together with some isolated findings in the adjacent Korčula Island, south to the Pelješac Peninsula. The new species could inhabit also the Rilić Mts., the area south from Biokovo Mts., and Kozjak Mts. above Split.

This distribution range belongs mainly to the Middle Dinaric biogeographical region (Ozimec, 2009), with its high cave biodiversity, including newly discovered rich cave populations of *E. biokovensis* **sp**. **n**. Therefore, *E. biokovensis* **sp**. **n**. can be considered a Middle Dinaric endemic and a subtroglophilic species.

Specimens of *E. biokovensis* **sp**. **n**. have been found in caves, usually approximately down to 20 m depth, at the altitudes from 25 m a. s. l. (Mala Jama Pit) to about 1550 m a. s. l. (Stara Škola Pit) in the region of Biokovo Mts. Most caves are small or middle-sized, and specimens are regularly found in the first chamber or along the entire cave.

Compared to its closest taxon, *E. feti*, the range of *E. biokovensis* **sp**. **n**. is located more to the northwest; also, the new species was found at higher altitudes, to 1550 m a. s. l. Even on the island of Korčula, it was found only near Pupnat Village, above 300 m a. s. l.; the same was true for the Pelješac Peninsula (386 m a. s. l.). The few findings south of the Neretva River could be due to imports, relict populations, causes of competition with *E. feti* etc. Surely they still require confirmations, and further ecological and biogeographical observations (the sampling was done for biospeleological purposes, not aimed at the search for scorpions, therefore no external research was done).

Cave habitats. Some of specimens were found in a cave habitat classified as "semi-caves and entrance part of caves" (EUNIS habitat code H.1.1.; NKS H.1.1.1.), and some of them were collected in "caves and cave systems with troglophilic invertebrates" (EUNIS habitat code H.1.2.; H.1.25; NKS H.1.1.5.). In Gradina Cave, *E. biokovensis* **sp**. **n**. occurred in the habitat classified as "caves and cave systems with subtroglophilic vertebrates" (EUNIS habitat code H.1.22; NKS H.1.1.3.). Most interesting findings are in the habitat classified as "caves and cave systems with troglobitic invertebrates" (EUNIS habitat code H.1.23; NKS H.1.1.4.), as well as in Baba cave, Jama za Supinom, both on Biokovo, same as type locality Drinova 2 cave, where specimens can be regularly found in the last, deep cave chambers, together with many troglobitic taxa endemic to deep cave habitats.

Microclimate. During biospeleological studies in all caves, the basic microclimate parameters were measured: air temperature, air humidity, substrate temperature, water temperature, relative humidity, wind speed, CO_2 concentration, and illumination. Most of habitats have the standard environment of total darkness, moderate temperature, high humidity, and no wind. Most variable temperature range in the places where *E. biokovensis* **sp**. **n**. has been found, was from 8.0°C in the Špilja u Radinovcima Cave to 16.1°C in the Kukor Cave for the air, and from 8.0°C to 15.3°C for the substrate. In the last chamber in the type locality, Drinova 2 Cave, regularly populated by scorpions, average measurements are 12.2°C for air and 11.8°C for substrate.

Bionomics. Scorpions were usually collected under stones, both on wall sides and on floor, some specimens also were under stones, but not affixed on the stone. Sometimes, scorpions occurred directly on the cave walls or roofs, most probably hunting. In the Kukor Cave on 8 November 2015, one female was found actively hunting the cave cricket *Dolichopoda araneiformis* (Fig. 20).

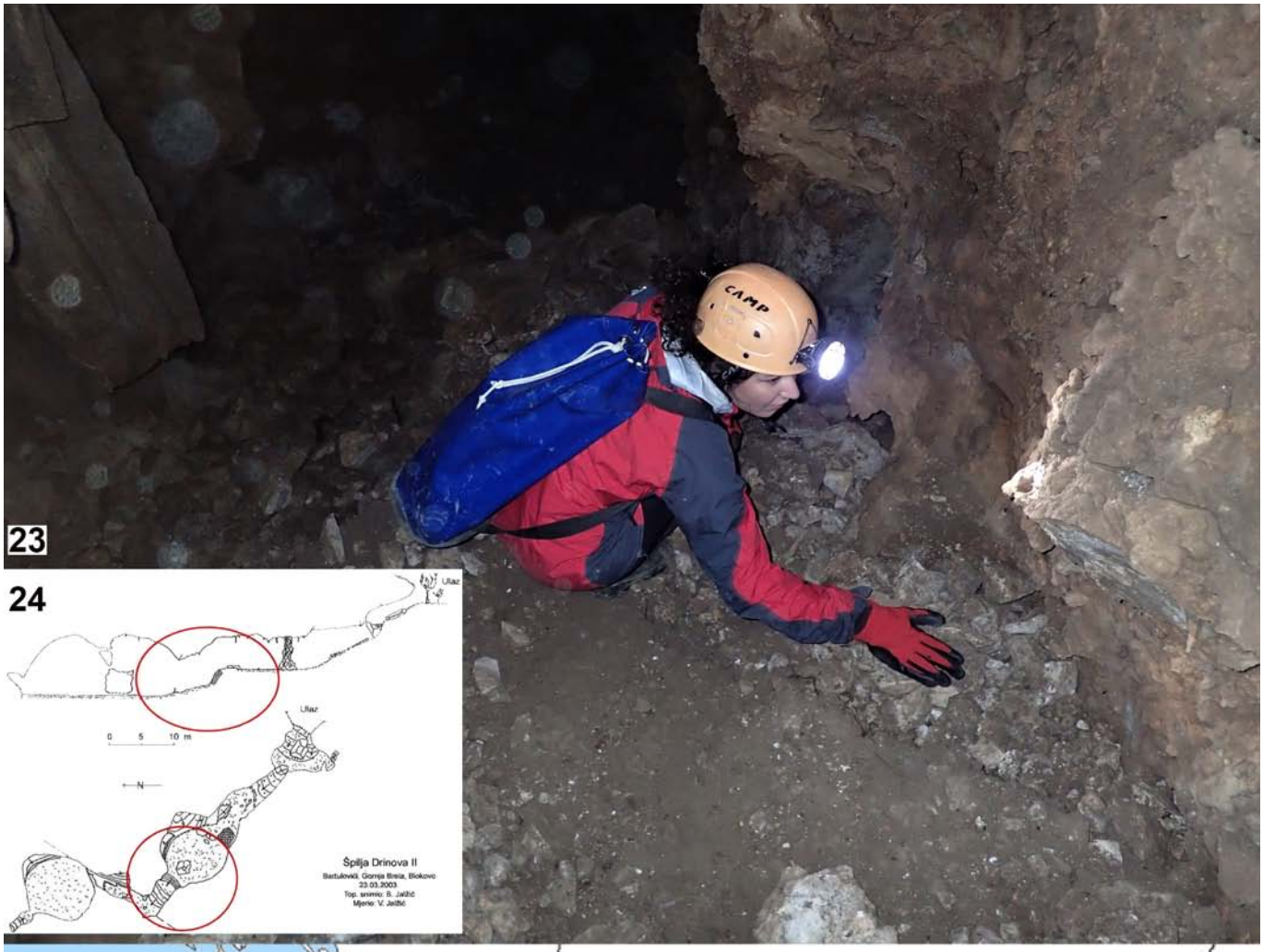
Accompanying cave fauna. Many troglophilic and troglobitic animals inhabit the same caves and cave habitats together with *E. biokovensis* **sp**. **n**. The following terrestrial taxa can be found there: Gastropoda: *Hypnophila*, *Spelaeoconcha*, *Vitrea*; Isopoda: *Alpioniscus*; Diplopoda: *Apfelbeckia*, *Brachydesmus*; Chilopoda: *Lithobius*, *Eupolybothrus*; Araneae: *Barusia*, *Meta*, *Nesticus*, *Histopona*, *Stalagtia*, *Sulcia*, *Tegenaria*, *Typhlonyphia*; Opiliones*: Cyphophthalmus*, *Nelima*, *Trogulus*; Pseudoscorpiones: *Chthonius*, *Neobisium*, *Roncus*; Diplura: *Stygiocampa*; Collembola: *Verhoefiella*; Coleoptera: *Laemostenus*, *Neotrechus*, *Speonesiotes*, *Thaumastocephalus*; Orthoptera: *Dolichopoda*, *Grylomorpha*, *Troglophilus*; and many others, but no other scorpion taxa.

Besides *E. biokovensis* **sp**. **n**., several *Euscorpius* species have been found in caves, e. g. *E. aquilejensis* (C. L. Koch, 1837), *E. birulai* Fet et al. 2014, *E. giachinoi* Tropea & Fet, 2015, and *E. feti* Tropea, 2013 (Fet et al., 2014; Tropea, 2013a; Tropea & Fet, 2015; Tropea & Ozimec, 2019). All these species also clearly have more elongated features than most of other *Euscorpius*. In addition, many *Euscorpius* species are often found in the garages, basements, or other human constructions, which could be considered a sort of artificial caves. Thus, it is quite possible that some *Euscorpius* species are more or less troglophilic, opportunistic taxa, and spend part or all of their lives inside a cave or a similar habitat, as does *E. biokovensis* **sp**. **n**.

Discussion

Taxonomy of the subfamily Euscorpiinae is complicated, and for many areas and species complexes it still remains unresolved. The Balkans host a number of Euscorpiinae populations that need further study; since 2012, three new species have been described (*E. biokovensis* **sp**. **n**., *E. borovaglavaensis*, and *E. feti*), and two more were restored and elevated to species status (*E. aquilejensis* and

Figures 21–**22**: *Euscorpius biokovensis* **sp**. **n**., type locality, cave entrance and surrounding environment (21) and internal cave where specimens have been found (22).



Figures 23–**25**: *Euscorpius biokovensis* **sp**. **n**. **Figure 23**. Internal cave where specimens have been found. **Figure 24**. Drinova 2 map with marked part of cave (red line) where specimens were regularly found (after Jalžić, 2005, amended). **Figure 25**. Distribution map with type locality in red.

E. croaticus) (Graham et al., 2012; Tropea, 2013a, 2013b, 2015; and the present work). It is likely that several new species will be described and others will be restored and elevated to species status from this area in the near future. Continuous changes in the taxonomy of this genus has further contributed to the confusion between the various species and populations. Specimens of the subgenus *Euscorpius* s. str. (or similar to it), which occur within the range of *E. biokovensis* **sp**. **n**. (or close to it), in the past have been addressed as: *E. carpathicus mesotrichus* and *E. c. polytrichus* after Hadži (1929); *E. c. tergestinus* and *E. c. hadzii* after Di Caporiacco (1950); *E carpathicus* and *E. mesotrichus* after Kinzelbach (1975); and *E. tergestinus* and *E. hadzii* after Fet & Soleglad (2002). In addition, all the populations and species belonging to the subgenus *Euscorpius* and/or similar to it, have been addressed as "*E. carpathicus* complex". Furthermore, specimens of many populations are hard to find both in nature and in museum collections, where the labelling often does not help for the reasons mentioned above. *E. biokovensis* **sp**. **n**. may have been "obscured" by unclear labelling and by the fact that the specialists too often looked only at the variable number of trichobothria and geographic area neglecting other important morphological characters, as well as by its cave preference. No other scorpion species was found together with *E. biokovensis* **sp**. **n**., but the same area is inhabited by *E. borovaglavaensis*, *E. hadzii*, and possibly by *E. tergestinus* and *E. aquilejensis* (Tropea, unpublished data), and in the Korčula Island, by *E. feti.* All these species are separated from *E. biokovensis* **sp**. **n**., as explained above. At the same time, *E. biokovensis* **sp**. **n**. seems to be very close to *E. feti*, both morphologically and ecologically, excluding the trichobothrial and pectinal teeth count. Both of these species share the following features: all segments of pedipalps particularly long and thin; pedipalp femur longer than patella; elongated carapace with its rear part constituting about 60% of the total length; distally located trichobothrium *db* on the fixed finger; and unpaired distal spinules on ventral aspect of the tarsus, as well as other, partially similar characters such as carination and granulation. Some of these characters (e. g. particularly elongated general habitus, pedipalps and metasomal segments) could also be an partial adaptation to cave life; other species known from caves and/or cave-like artificial environments, in part share them, such as *E. aquilejensis*, *E. birulai*, and *E. giachinoi*.

Tropea (2013) pointed out that some *Euscorpius* species, including *E. aquilejensis*, do not belong to the subgenus/genus *Euscorpius* s. str. Currently, the subgeneric/generic composition of the genus *Euscorpius* is still unclear and the existing identification keys to its species are largely obsolete. Due to its similarities with *E. aquilejensis*, and thus the differences with the species confirmed for the subgenus *Euscorpius* s. str. (with the type species *E. carpathicus* (Linné, 1767)), we prefer to place *E. biokovensis* **sp**. **n**. under a "subgenus *incertae sedis"*. Therefore, the new species not assigned to any subgenus for the moment, pending further studies, including genetic analysis, to understand its relationship with other species of the Euscorpiinae.

Also, we are continuing research to better understand the true distribution and ecology of the new species, as well as of the other species of Euscorpiinae including potentially new taxa.

Acknowledgments

We would like to thank especially the specimen collectors (listed alphabetically): Damir Basara, Jana Bedek, Marijana Cukrov (ex Franičević), Alen Kirin, Marijana Klisović Kalauz, Darijan Ozimec, Martina Pavlek, Toni Tursić, and Ines Vuković. We also thank Victor Fet and an anonymous reviewer for the review of text.

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